Citizen Science Bird Survey in the Cowichan Valley in Support of the Pacific Salmon Foundation's Salish Sea Program 2014

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CITIZEN SCIENCE BIRD SURVEY IN THE COWICHAN VALLEY IN SUPPORT OF THE PACIFIC SALMON FOUNDATION'S SALISH SEA PROGRAM 2014

by

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ABSTRACT

Wade, J. 2014. Citizen science survey in the Cowichan Valley in support of the Pacific Salmon Foundation's Salish Sea Program 2014. Can. Manuscr. Rep. Fish. Aquat. Sci. 3044: iv + 30 p.

A citizen science based bird census was undertaken in Cowichan Bay estuary and in one reach of Cowichan River during the outmigration of hatchery Chinook salmon in 2014. This project was a part of the larger Pacific Salmon Foundation "Salish Sea Program" to investigate the sources of early marine mortality of hatchery salmon. The survey focused on the collection of preliminary data on the abundance and composition of species between the end of April and end of June in designated observation areas. Some additional work was performed in order to be able to provide advice on design for future bird surveys in the estuary. Opportunistic scat collection was also undertaken in the Cowichan Bay estuary for future diet analysis. The design of this study does not allow for the estimation of salmon mortality due to bird predation, nor was this a goal of the study which was to provide preliminary information on the bird community at the time of outmigration of hatchery Chinook salmon.

RÉSUMÉ

Wade, J. 2014. Relevé scientifique axé sur la science citoyenne réalisé dans la vallée de Cowichan à l'appui du Programme de la mer des Salish de 2014 de la Fondation du saumon du Pacifique. Rapp. manus. can. sci. halieut. aquat. 3044 : iv + 30 p.

Un recensement des oiseaux axé sur la science citoyenne a été effectué en 2014 dans l'estuaire de la baie Cowichan et un tronçon de la rivière Cowichan pendant la dévalaison des saumons quinnat d'écloserie. Ce projet, qui s'inscrivait dans le vaste « Programme de la mer des Salish » de la Fondation du saumon du Pacifique, visait à déterminer les causes de mortalité des saumons d'écloserie au cours de leurs premières phases marines. L'étude visait principalement à recueillir des données préliminaires sur l'abondance et la composition des espèces entre la fin du mois d'avril et la fin du mois de juin dans des zones d'observation désignées. Des travaux supplémentaires ont été réalisés afin d'être en mesure de fournir des avis sur la conception des prochaines études sur les oiseaux qui seront menées dans l'estuaire. Un échantillonnage sporadique des matières fécales a également été fait dans l'estuaire de la baie Cowichan en vue d'une analyse future du régime alimentaire. La présente étude ne visait pas à estimer le taux de mortalité des saumons attribuable à la prédation par les oiseaux, mais plutôt à fournir des renseignements préliminaires sur les populations d'oiseaux présentes au moment de la dévalaison des saumons quinnat d'écloserie.

INTRODUCTION

The Pacific Salmon Foundation has initiated a multi-year, multi-location Salish Sea Program to investigate reasons for early marine mortality in salmon. The first location chosen for these studies is Cowichan River and Cowichan Bay on the east coast of Vancouver Island. This location was chosen, in part, because of continued low returns of hatchery Chinook salmon to the Cowichan River. Studies in the Gulf Islands and Cowichan Bay in 2008 by Beamish et al (2012) showed a large mortality in the first five months after ocean entry, with mortality of hatchery Chinook salmon greater than wild Chinook salmon.

Because it is unlikely that the early marine mortality of Cowichan River Chinook salmon is the result of one threat, many potential sources of mortality are under investigation beginning in 2014. Avian predation is one such potential threat. Due to limited time constraints in designing and implementing this survey in advance of the release of hatchery fish, efforts were concentrated in the Cowichan Bay estuary for the months in which Cowichan Chinook salmon are in the nearshore area with additional data collection in the Cowichan River as opportunities arose.

Ideally, this survey would be carried out throughout the year and include extensive observations in freshwater. Because many birds spend part of the year foraging in freshwater and part in salt water, this information would help in the determination of predation on salmon eggs during incubation and in river fry predation in the spring and summer. Additionally, because Chinook salmon are not the only salmon species in the system, a yearlong survey would be able to inform ecosystem interactions and may identify other piscivorous birds putting pressure on other salmon species throughout the year.

The goal of this survey is to collect preliminary data on the bird community in the Cowichan River system to eventually be incorporated with data collected by other groups funded by the PSF Program to shed light into the sources of early marine mortality of Cowichan River salmon. Enumeration and abundance surveys of Cowichan Bay estuary and one reach of the Cowichan River were undertaken. Some additional work was performed in order to be able to provide advice on design for future bird surveys in the estuary. Opportunistic scat collection was also undertaken in the Cowichan Bay estuary for diet analysis.

METHODS

Enumeration and Abundance Surveys

Cowichan Bay Estuary

Observations

This survey was a citizen science based project led by Fundy Aqua Services (FAS), all data were collected by a combination of local citizens, students and FAS. This project would not have been possible without the active participation of local experts.

Standard bird survey methodologies (Bibby et al., 2000) based on species limits per time within a constrained area have been utilized in the design of this study. Species identification and

enumeration were made by individuals over a minimum of 15 minutes at the scheduled times and dates described below. Time was recorded in order to standardize counts. A combination of bionoculars and spotting scopes were used in making observations. If a positive identification was not possible, the individual was counted and marked unknown "X". For example, if a gull species could not be discerned it was recorded as UNGU (unidentified gull). All birds were identified and enumerated regardless if they were believed to be piscivorous or not. This allows for a more encompassing description of the avifauna and their possible interactions.

Notes were made with respect to activity during the observation period which may affect the birds such a boat traffic, dogs, predators or weather conditions. Other information such as when birds were nesting or when young first appeared were also noted by observers. These qualitative data are used in defining the seasonal progression of avifauna.

Survey area

Five observation areas were delineated in Cowichan Bay in order to ensure as much coverage of the area as possible (Figure 1). Two of these five areas are the same as those used in the Bird Studies Canada, Coastal Waterbird Survey. The five areas are (Figure 1): observation tower near the Nature Center (Tower NC), observation tower on the farm (Tower Farm), stevedore causeway (Causeway), bridge over the north arm of Cowichan River (NA Bridge) and Khenipsen Rd and /or Gore Langton Rd (KGL). Observations at Khenipsen Rd terminated May 30, another observation area, Gore Langton Rd, with a slightly reduced area than that at Khenipsen Rd was used for the month of June. For the purposes of this report, these locations were considered one view point.

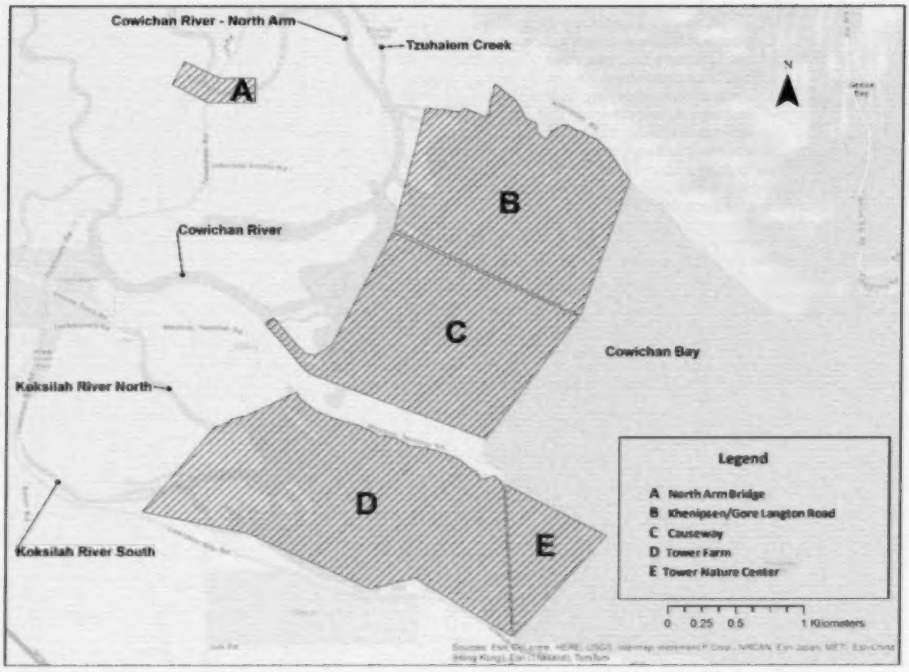

Figure 1: Survey area delineations in Cowichan Bay (observation areas are approximate)

Timing

Between April 22nd and May 30th 2014, observations were made twice a week on Tuesdays and Fridays within 2 hours of sunrise and 2 hours before sunset each day.

Observing two days a week allowed for the capture of rapid changes in species number and diversity. The timing of observations, near sunrise and sunset, was chosen to be able to include many different tidal heights at times of day when birds are traditionally known to be active. In addition, because of the large, low gradient estuary in Cowichan Bay, there was a desire to determine the best time of day and tidal height at which to observe potential piscivorous birds.

For the month of June, observations were reduced to once per week on Tuesdays, again within 2 hours of sunrise and 2 hours before sunset at all locations except the north arm bridge. The bridge was excluded for the second part of the survey due to low overall abundances and diversity of avifauna. The entire study took place between April 22nd and June 24th, 2014.

Analysis

Data have been analysed and summarized based on survey location. For each observation period, the number of species observed has been corrected to 15 minute observation times. Because it is recognized that the same individual bird may be counted in the morning and afternoon average daily number of birds observed per species for each location is presented. Numbers have been rounded up to the nearest whole number (bird).

Once species diversity and number by location was determined, data pertaining to piscivorous or potentially piscivorous species were extracted and all areas combined. The total daily counts per species (30 minutes) as well as the average daily counts have been presented. In the event that two observations per day were not made, that day was excluded from the analysis.

Cowichan River

Species identification and abundance were recorded for one reach of the Cowichan River by Mr. J. Saysell, a local drift fisherman. In addition, for Common Mergansers, the sex of the adults was also recorded, as was the presence of ducklings. Observations were recorded from the fisherman's residence to Skutz Falls between May 10th and June 16th 2014 (Figure 2) and included the number of hours drifted. This distance is approximately 14.5 km. Over this time period, 16 drifts were made, they were terminated on the 16th of June due to low water conditions in the river. Anecdotal information about the Cowichan River, the fishes and birds was also provided by the fisherman who is a life-long resident of the area, avid outdoorsman and local activist.

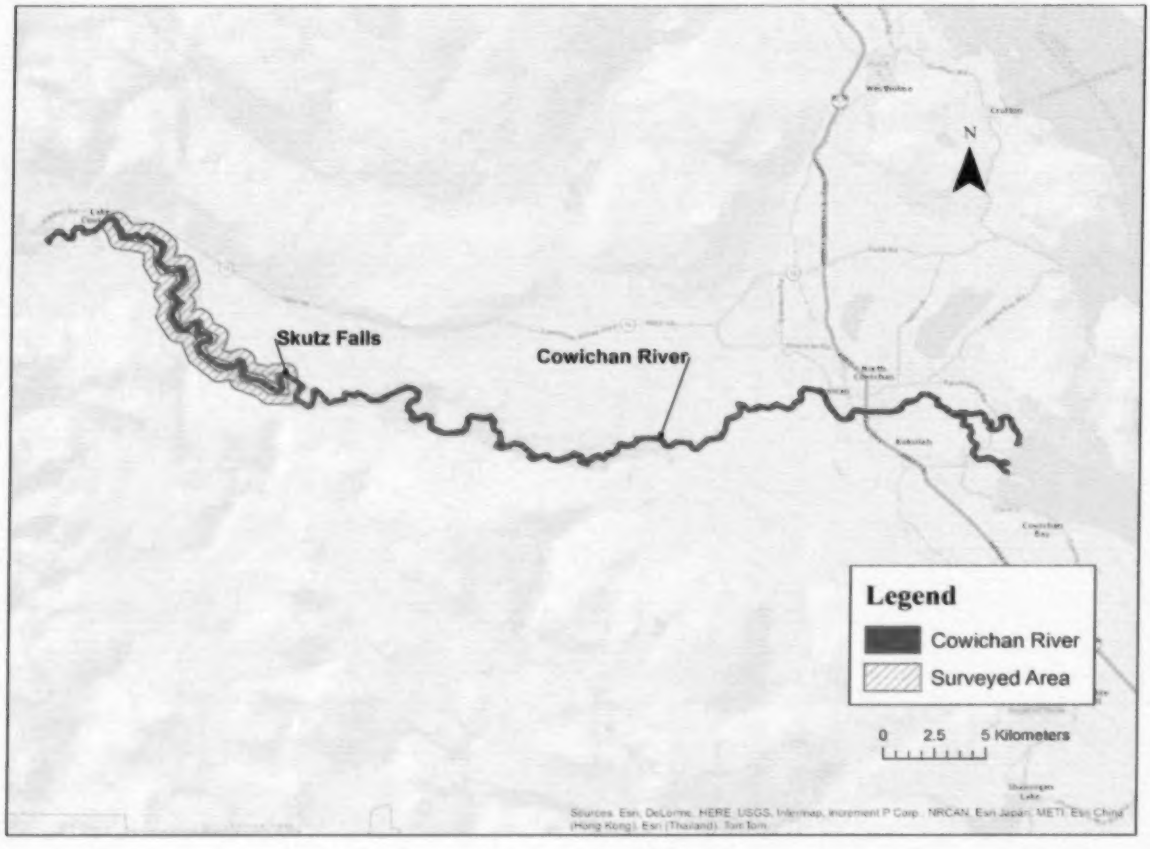

Figure 2: Bird survey area in the Cowichan River (approximately 14.5km)

Observation Timing Assessment

The Bird Studies Canada, Coastal Waterbird Survey make their observations within 2 hours of high tide. Because of the low grade, expansive estuary area in Cowichan Bay and the abrupt drop off from the shore on the north side of the bay, it was not known if this would be the best methodology to capture the true diversity and abundance of birds for the purposes of this survey.

In order to inform future survey methodologies in Cowichan Bay estuary the observations recorded for each major piscivorous species were analysed with respect to tidal height and time. Because there are only two times per day which were observed, it was not possible to correlate the observation data with time. Instead, we compared medians for count data using a Kruskal Wallis test.

In addition to the main survey, a one day survey was undertaken with the explicit purpose of examining the correlation between bird counts, time and tidal height. Observations were made at the Gore Langton Rd. and Causeway locations beginning 2 hours after sunrise, every 3 hours, for 15 minutes and ending 2 hours before sunset. This survey took place on May 15, 2014 as there

were extreme high and low tides that day. Pearson correlation was performed on total counts of Common Merganser, Great Blue Heron and gull sp.

Scat Collection

Opportunistic bird scat collections were made in the Cowichan Bay estuary by FAS and volunteers. Some samples were also collected by J. Saysell on the Cowichan River. Collections were only made from birds observed to have deposited the scat in order to ensure a positive identification. Scat was scooped up with a popscicle stick and placed in a scintillation vial with ethanol for DNA analysis. A new popscicle stick was used for each sample collected. All vials were labelled with species and date. Ideally, it would be best to analyse scat from birds who have been fed known salmon species. However, scat were collected in order to provide material for the lab to begin determining methodologies for analysis. DNA analysis of scat is outside the scope of this project.

RESULTS

Enumeration and Abundance Surveys

Cowichan Bay estuary

Species diversity

A total of 31 different species were recorded (including unidentified categories) in Cowichan Bay estuary (Table 1).

Table 1: Species identified in the survey

Acronym	Species or group	Scientific Name
AMWI	American Wigeon	*Anas americana*
BAEA	Bald Eagle	*Haliaeetus leucocephalus*
BEKI	Belted Kingfisher	*Megaceryle alcyon*
BUFF	Bufflehead	*Bucephala albeola*
CAGO	Canada Goose	*Branta canadensis*
COGO	Common Goldeneye	*Bucephala clangula*
COME	Common Merganser	*Mergus merganser*
CORA	Common Raven	*Corvus corax*
DCCO	Double-crested Cormorant	*Phalacrocorax auritus*
GADW	Gadwall	*Anas strepera*
GBHE	Great Blue Heron	*Ardea herodias*
GRSE	Greater Scaup	*Aythya marila*
GWGU	Glaucous-winged Gull	*Larus glaucescens*
GWTE	Green-winged Teal	*Anas crecca*
HOME	Hooded Merganser	*Lophodytes cucullatus*
KILL	Killdeer	*Charadrius vociferus*
LESC	Lesser Scaup	*Aythya affinis*
MALL	Mallard	*Anas platyrhynchos*
MUSW	Mute Swan	*Cygnus olor*
NOCR	Northwestern Crow	*Corvus caurinus*
NOHA	Northern Harrier	*Circus cyaneus*
NSHO	Northern Shoveler	*Anas clypeata*
OSPR	Osprey	*Pandion haliaetus*
PUMA	Purple Martin	*Progne subis*
RBGU	Ring-billed Gull	*Larus delawarensis*
TUVU	Turkey Vulture	*Cathartes aura*
TRUS	Trumpeter Swan	*Cygnus buccinator*
UNDU	Unidentified Duck	
UNGU	Unidentified Gull	
UNSH	Unidentified Shorebird	
WIMB	Whimbrel	*Numenius phaeopus*

These species have been classed according to their feeding habits (Table 2); the majority are non-piscivorous. The number of individuals enumerated varies with the observation location but it can be generalized that the Great Blue Heron, Common Merganser and gull (sp.) were the most numerous piscivorous species counted (see results by area below).

Table 2: Classification of species observed according to feeding habits

Piscivores/possible piscivores	herbivore/carnivore/frugivore/inertivore/other
Bald Eagle (Watson et al., 1991)	American Wigeon (De Graaf et al., 1985)
Belted Kingfisher (White, 1937)	Bufflehead (Hornung and Foote, 2008)
Common Merganser (Kear, 2005)	Canada Goose (Buchsbaum and Valiela, 1987)
Double-crested Cormorant (Molina and Garrett, 1998)	Common Goldeneye (Bourget et al., 2007)
Glaucous-winged Gull (Calvino-Cancela, 2011)*	Common Raven (Careau et al., 2007)
Great Blue Heron (Butler, 1997)	Gadwall (Ankney and Alisauskas, 1991)
Herring Gull (Calvino-Cancela, 2011)*	Greater Scaup (Ross et al., 2005)
Hooded Merganser (De Graaf et al., 1985)	Green-winged Teal (Rave and Baldassarre, 1991)
Mew Gull (Calvino-Cancela, 2011)*	Killdeer (Fair et al., 1995)
Osprey (Palmer, 1988)	Lesser Scaup (Ross et al., 2005)
Western Gull (Calvino-Cancela, 2011)*	Mallard (Allen, 1986)
	Mute Swan (AOU, 1998)
	Northern Harrier (Collopy and Bildstein, 1987)
	Northern Shoveler (Ankney and Afton, 1988)
	Northwestern Crow (Saunders and Ydenberg, 1995)
	Purple Martin (Utter and LeFebvre, 1973)
	Trumpeter Swan (McKelvey and Verbeek, 1988)
	Turkey Vulture (Hiraldo et al., 1991)
	Whimbrel (Kvitek and Bretz, 2005)

*all gulls (*Laridae*) fall into other categories as well as piscivore: carnivore, inertivore, fructivore, etc.

Tower near the Nature Centre (Tower NC)

Nineteen different species of birds were observed throughout the survey period at the Tower NC location. Fifteen complete sample days are included in the summary. Large abundances of American Wigeon (total N=97) were observed on April 22nd all in the evening. They were not seen again at this location for the duration of the study.

American Wigeon was the species with the highest average daily count, followed by Glaucous-winged Gull (GWGU) (average counts ranged from 0-47 per day) and unidentified gull (UNGU) with average counts on May 30th of 39 and June 3rd of 35. Species which were consistently observed throughout the survey at this location were Purple Martin (average counts ranged from 0-25/day), Osprey (average counts ranged from 1-3/day) and Bald Eagle (counts range from 0-2/day). Other species reported in Figure 3 were often less than 10 individuals per day.

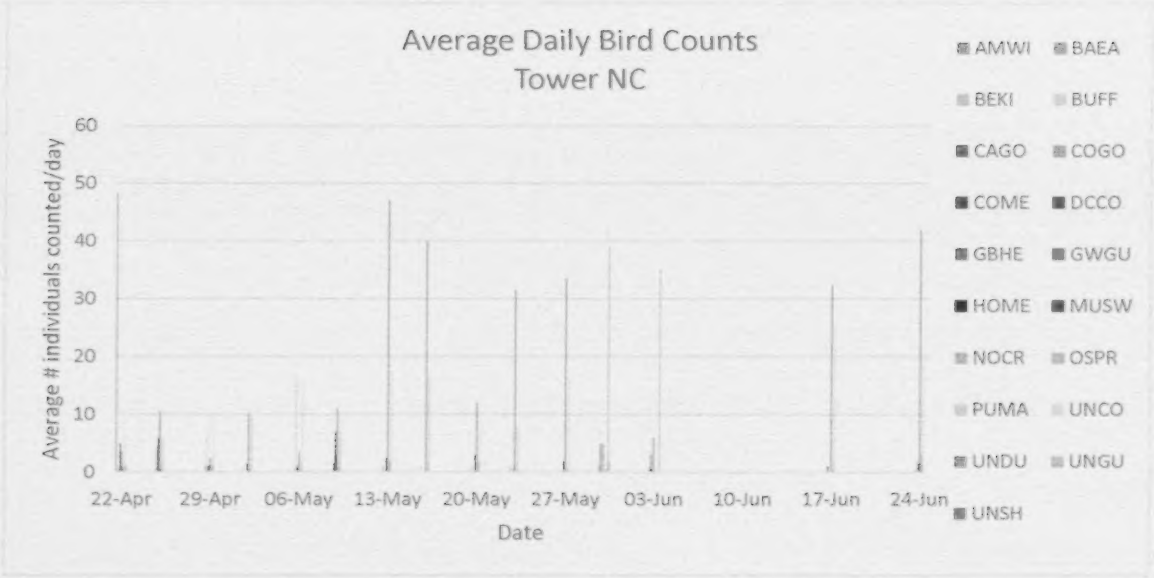

Figure 3: Average daily bird counts, all species, at Tower NC

Tower Farm

Twenty-four different species of birds were counted at this location. Fifteen complete sample days are included in the summary. The greatest number of individuals were counted between the end of April and mid May (Figure 4); most of which can be attributed to a large number of Bufflehead and Common Merganser. Average counts per day of Buffleheads were greatest on April 25th (N=36) followed by April 29th (N=12) and May 2nd (N=5). The highest daily average count of Common Merganser was 44 individuals on May 2nd. Average daily counts of Great Blue Heron ranged from 2 to 19 individuals per day.

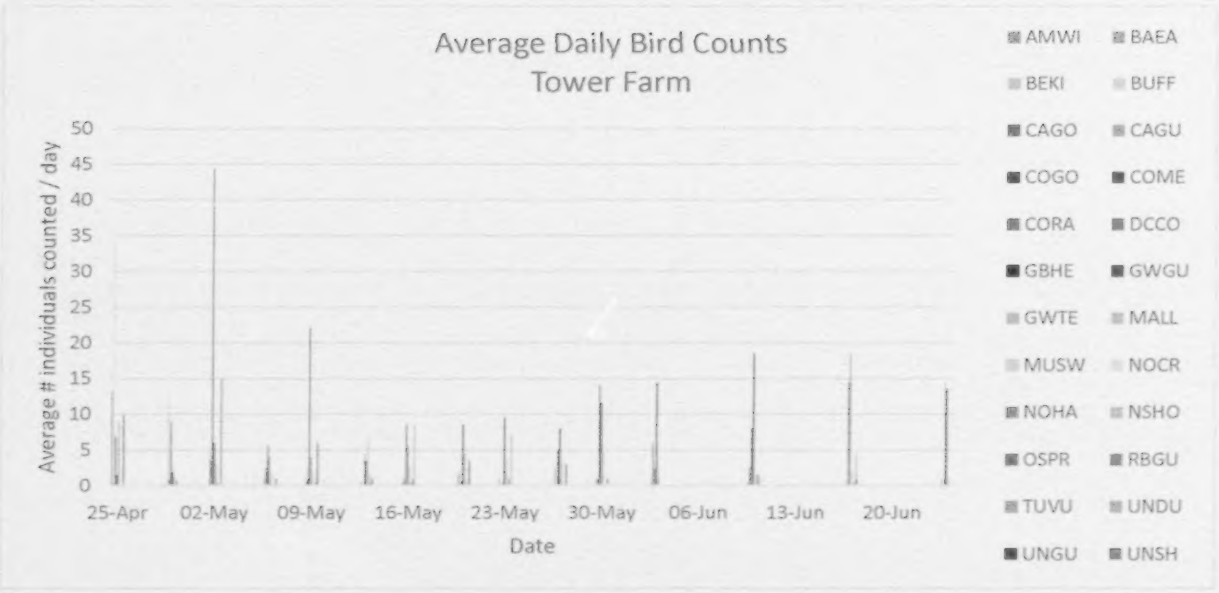

Figure 4: Average daily bird counts, all species, at Tower Farm

Causeway

Twenty-four different species were observed from the causeway observation point. Thirteen complete sample days are included in the summary. The greatest average number of Green-winged Teal (N= 206) counted was on April 25th, on the same day, an average of 51 American Wigeon were also counted. Other abundant species included Canada Goose (average daily counts ranged from 0-18), Great Blue Heron (average daily counts ranged from 2-8), Common Merganser (average daily counts ranged from 1-21) and unidentified gulls (average daily counts ranged from 0-27) (Figure 5).

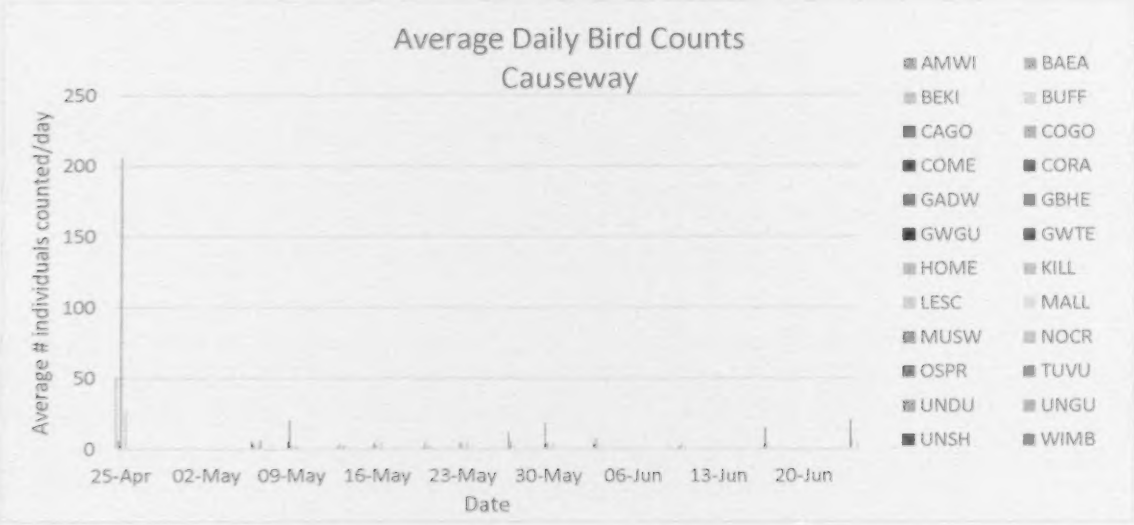

Figure 5: Average daily bird counts, all species, at Causeway

Bridge

The bridge over the north arm of the Cowichan River had the lowest abundances and species diversity of all locations. Ten different species were observed. Ten complete sample days are included in the summary. Over the entire time period, 137 individual birds were enumerated. The most abundant species over the survey period was the Canada goose (average daily counts ranged from 0-9) followed by Great Blue Heron (average daily counts ranged from 0-3) and Northwestern Crow (average daily counts ranged from 0-4) (Figure 6).

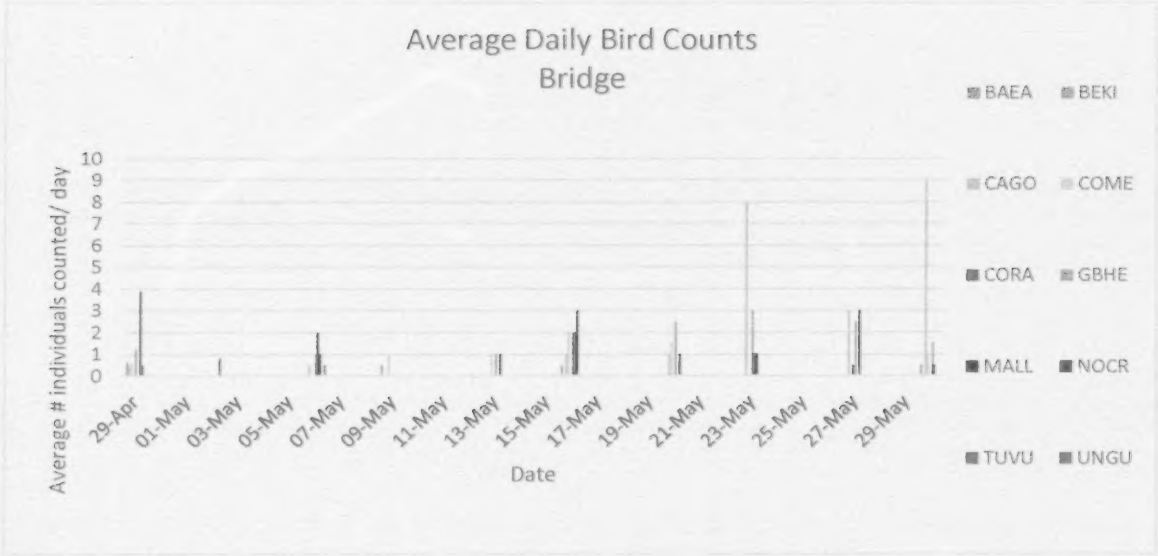

Figure 6: Average daily bird counts, all species, at Bridge

Khenipsen Rd. / Gore Langton Rd. (KGL)

Throughout the survey, twenty-four species were observed at this location. Fifteen complete sample days are included in the summary. Presence of Buffleheads dominates the last part of April and beginning of May 2014, average counts per day were: 146 on April 22nd, 55 on April 25th, 43 on April 29th and 50 on May 2nd. After May 13th, no Buffleheads were reported. Large numbers of American Wigeons were also recorded in the three April observations (average daily counts N=24, 25 and 28) (Figure 7). Common Merganser and Glaucous-winged Gulls were present in relatively high abundances in April and May. Average daily Common Merganser abundances ranged from 0 to 45, peaking May 13th. With respect to total numbers, the greatest number of Common Mergansers counted was on May 13th (N=96) over a 25 minute viewing period. Great Blue Heron peaked in abundance on May 27th with an average daily count of 48 individuals. Unidentified gulls were also recorded at high abundances on May 27th (average daily count N=75). The decrease in Common Mergansers reported at the end of May followed by the increase at the end of June is explained by the absence of males of at the end of May and the presence of ducklings at the end of June. The time in between when few Common Mergansers are observed is believed to be a reflection of females incubating eggs.

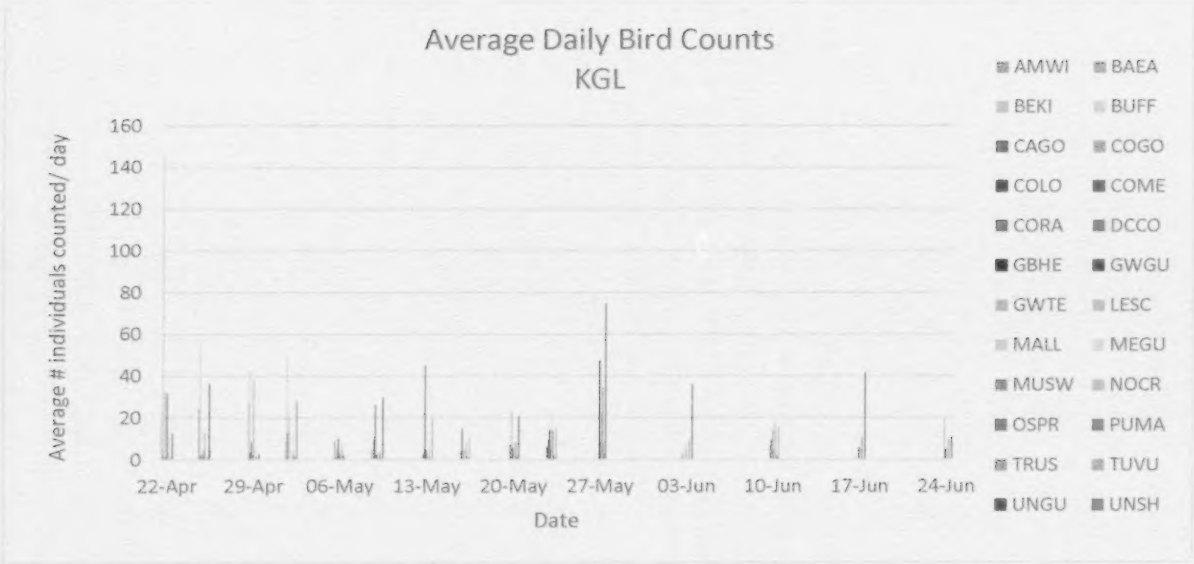

Figure 7: Average daily bird counts, all species, at KGL

Piscivorous Species

Common Merganser

When the total daily observations for Common Mergansers are summed for all locations (Figure 8) it is evident that there is a peak in numbers of individuals observed mid-May and again at the end of June. As stated previously, at the end of May, males leave the area and at the end of June, ducklings are present with females.

Figure 8: Total daily counts of Common Merganser (COME) all locations combined

At any one observation time, the maximum number of Common Merganser recorded from all locations was on May 9th in the morning (N= 98) followed by May 2nd in the evening (N=96). The highest average daily count of Common Merganser was on May 9th (N=76) (Figure 9).

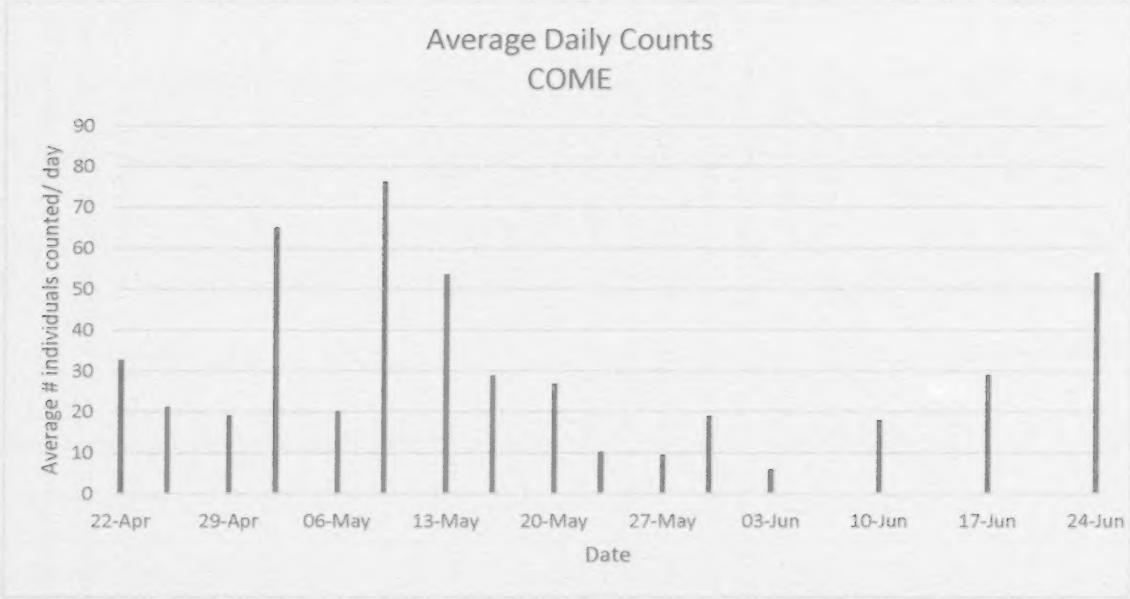

Figure 9: Average daily counts of Common Merganser (COME) all locations combined

Common Merganser were most commonly counted in the Khenipsen Rd. / Gore Langton Rd. (KGL) (N=446 sightings) observation location followed by the Tower Farm location (N=320 sightings) and Causeway (N=169 sightings) (Figure 10). Combining the KGL and Causeway counts (N= 615) covers the immediate estuary area on the north side of the causeway. The Tower Farm location includes the immediate estuary area on the south side of the causeway with some coverage of the inlets. The immediate estuary area combined results in a count of 935 Common Mergansers compared to the total counted of 979 throughout the entire survey area.

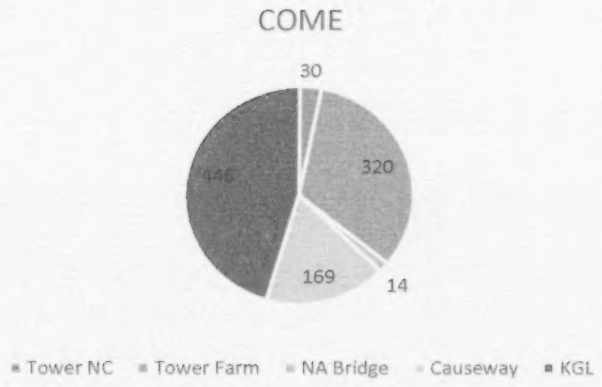

Figure 10: Common Merganser (COME) breakdown of all sightings by location

Great Blue Heron

When the total daily observations for Great Blue Heron are summed for all locations it is evident that there is an increase in numbers observed throughout April, a peak the end of May then counts level off to between 50 and 60 counted per day (Figure 11).

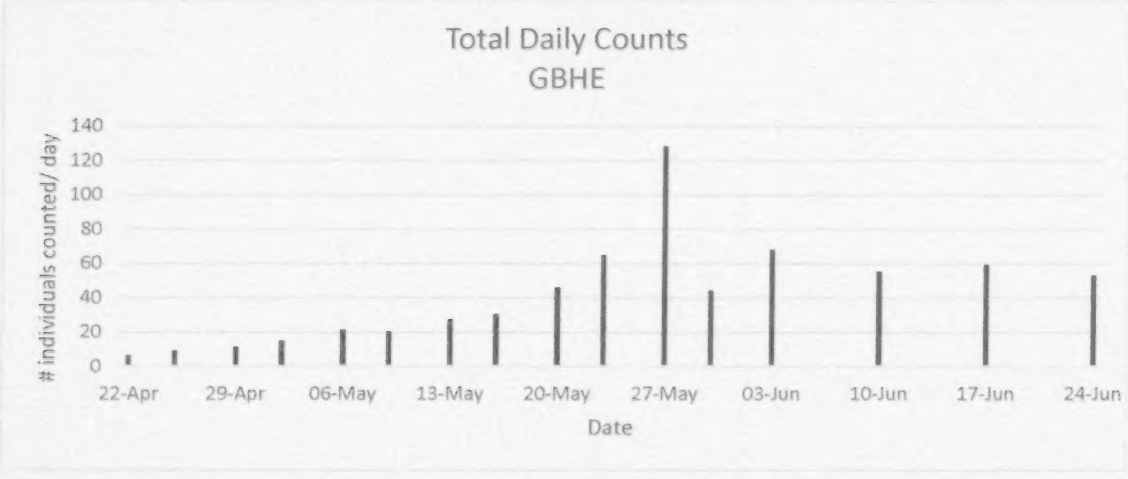

Figure 11: Total daily counts of Great Blue Heron (GBHE) all locations combined

The average daily count of Great Blue Heron over the entire survey was 20 with a range of between 3 and 64 (Figure 12).

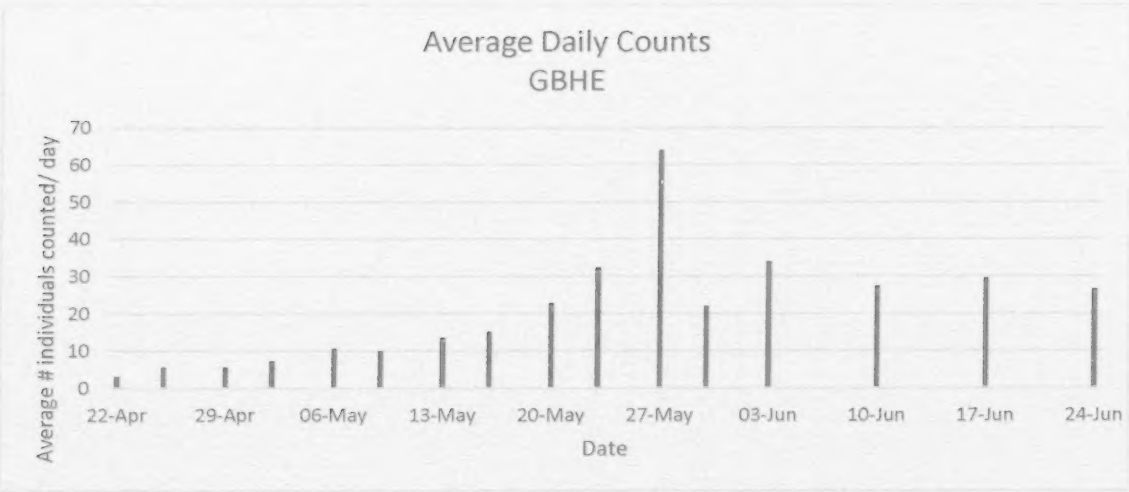

Figure 12: Average daily counts of Great Blue Heron (GBHE) all locations combined

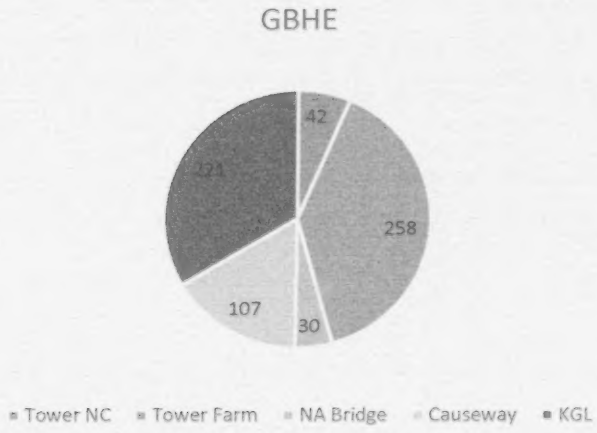

Figure 13: Great Blue Heron (GBHE) breakdown of all sightings by location

Great Blue Heron (GBHE) were most commonly counted in the Tower Farm location (N=258 sightings) followed by Khenipsen Rd. / Gore Langton Rd. (KGL) (N=221 sightings) and the Causeway (N=107 sightings) (Figure 13). Combining the KGL and Causeway counts (N= 328) covers the immediate estuary area on the north side of the causeway. The Tower Farm location includes the immediate estuary area on the south side of the causeway with some coverage of the

inlets. The immediate estuary area combined results in a count of 586 Great Blue Heron compared to the total counted of 658 throughout the entire survey area.

Gulls Sp.

All gull categories were combined for this analysis, they include in order of greatest to least abundant, Glaucous-winged Gull, unidentified gull and Ring-billed Gull. Total daily counts of gulls were greatest on May 27th with 239 birds recorded. The numbers of gulls counted per day varies between 19 and 239 (Figure 14).

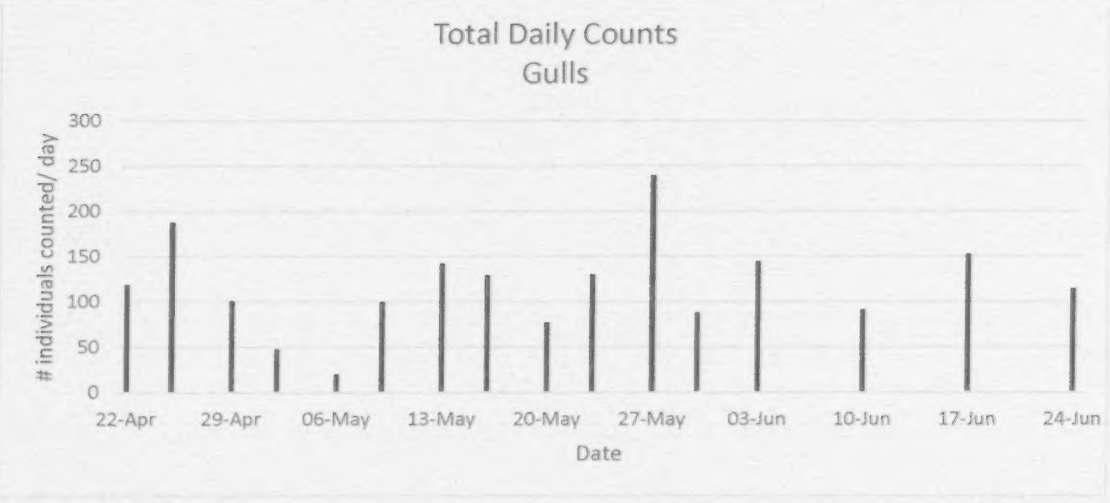

Figure 14: Total daily counts of gulls (sp.) all locations combined

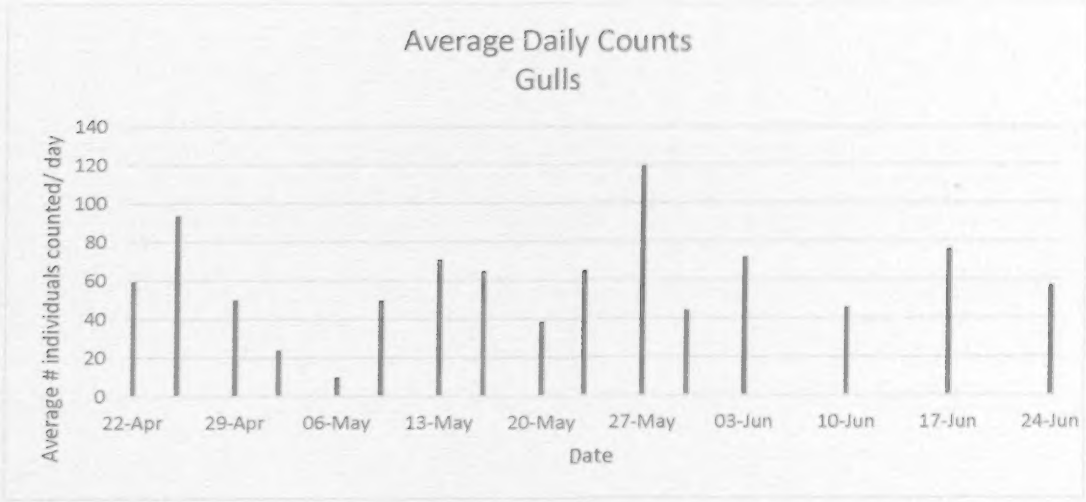

Figure 15: Average daily counts of gulls (sp.) all locations combined

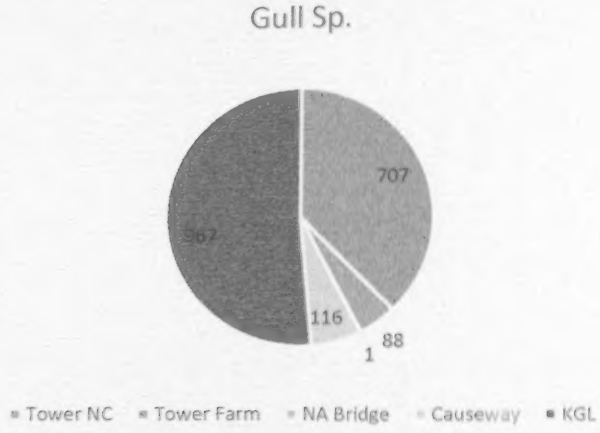

Figure 16: Gull (sp.) breakdown of all sightings by location

Gulls were most commonly counted in the Khenipsen Rd. / Gore Langton Rd. (KGL) (N=967 sightings) location, followed by the Tower at the Nature Centre (N=707 sightings). These sightings combined (N=1674) constitute 89% of the gulls enumerated.

Survey Areas

Although the number of gulls viewed from the Tower NC location were higher than all other locations with the exception of KGL, this location is not the best location for viewing Great Blue Herons or Common Mergansers. Great Blue Heron and Common Merganser are best viewed

from Tower Farm or KGL (Figure 17). The causeway location has much reduced counts of these species, however, the area is much smaller and 2 fewer days were surveyed. These data are not provided for quantitative comparison but to illustrate the relative counting success between locations for future studies for these select species.

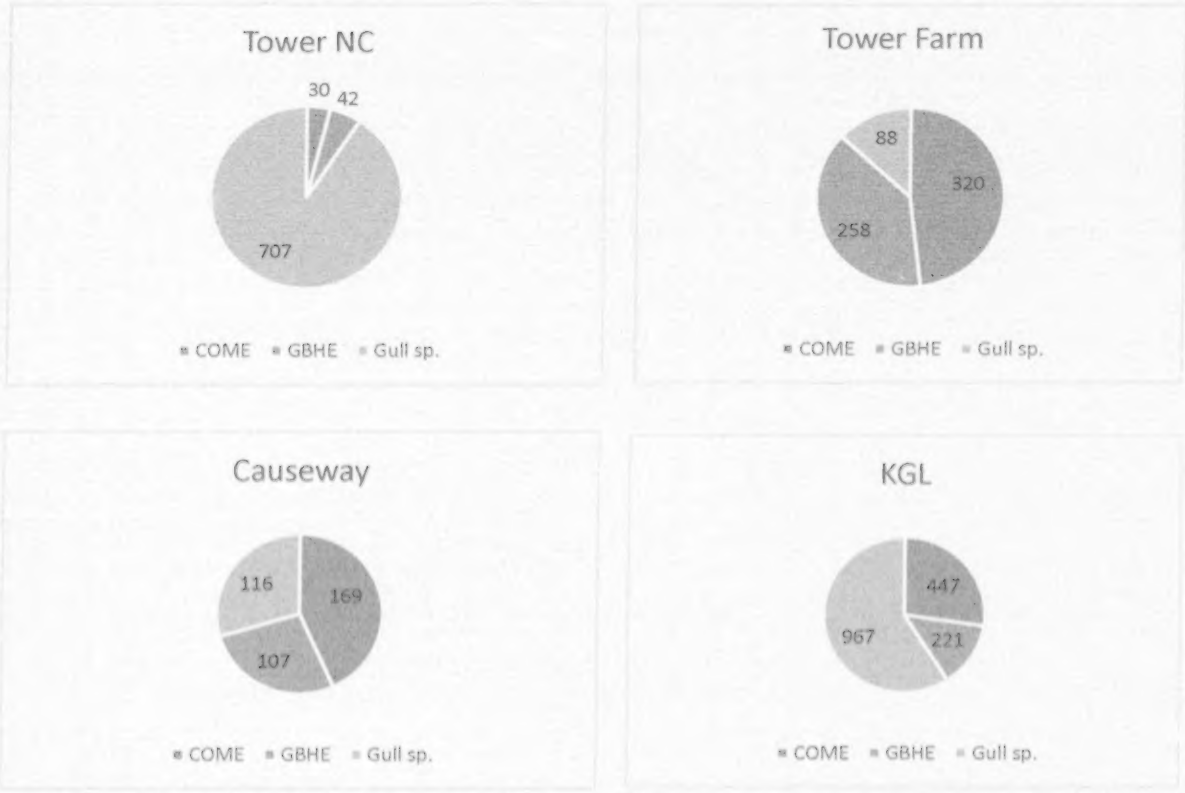

Figure 17: Total number of Common Merganser, Great Blue Heron and gull (sp.) counted by survey area

Other piscivorous birds

Osprey, Double-crested Cormorant, Belted Kingfisher and Bald Eagles are all piscivorous birds which were enumerated in this survey. Because of their relatively low abundances they will not be discussed at length. There were four active Osprey nests in Cowichan Bay during this survey, three of which were visible in the survey areas. The survey spanned the nesting, breeding and hatching of Osprey. We had the fortune to witness a mating event on one nest on May 1st

followed by the appearance of hatchlings a few weeks later. Double-crested Cormorants were only counted in the Tower NC and KGL areas. Total counts per day in Tower NC ranged from 0-12, for KGL they ranged from 0-2. The maximum number of Belted Kingfisher counted in any day from any location was 2. In general, they were rarely seen. The greatest number of Bald Eagles was counted in the KGL location, total daily counts ranged from 0-11. In the Tower NC and Causeway areas counts ranged from 0-3 per day, in the Tower Farm area daily counts ranged from 0-5 and in the Bridge area 0-1.

Cowichan River

Bird counts on Cowichan River were made from 10 May to 16 June, 2014 over the area 14.5 Km upstream of Skutz Falls. Five different species were counted including: Osprey, Common Merganser, Belted Kingfisher, Bald Eagle and Great Blue Heron (Figure 18). Common Merganser was the most frequently counted species (Figures 18).

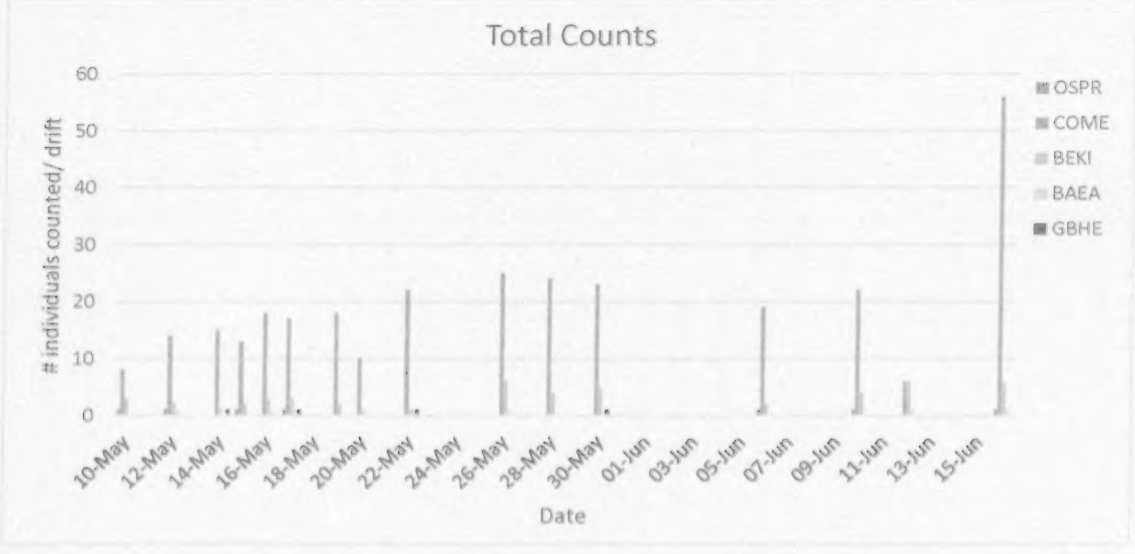

Figure 18: Total counts of all individuals (all species) made on the Cowichan River on an individual drift (day)

The first instance of Common Merganser ducklings occurred on May 22nd, at which time, the number of males begins to decrease and no males were seen after May 30th. A peak of 42 ducklings was counted on the last drift on the 16th June. These numbers may have continued to increase, however it was not possible to drift the River due to low water conditions. The maximum number of males reported in any one drift was 8 on May 16th, the maximum number of females reported in any one drift was 14 on June 16th (Figure 19).

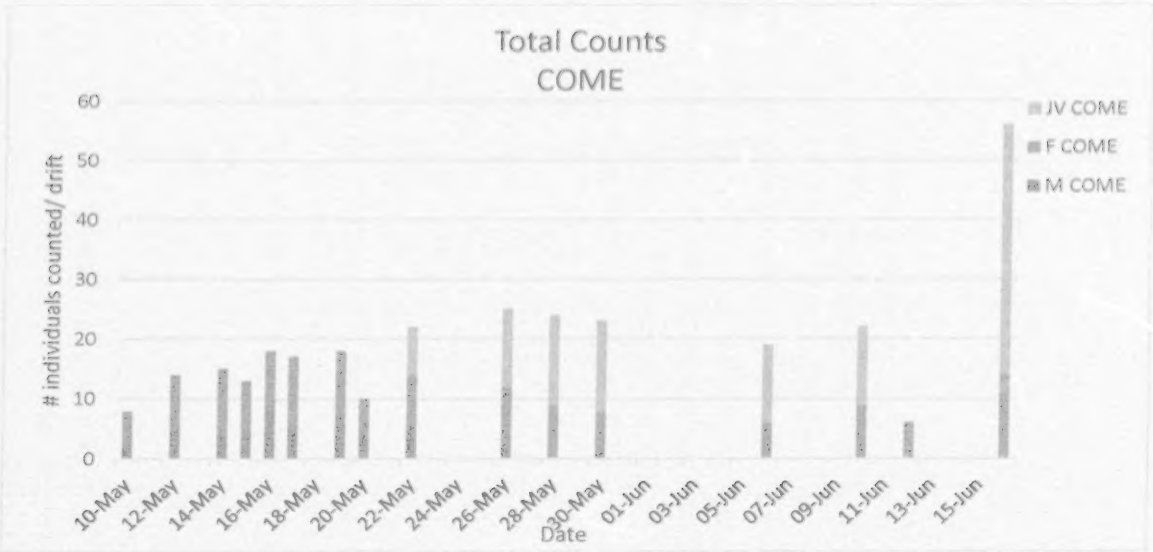

Figure 19: Total counts of Common Mergansers (COME) made on the Cowichan River on an individual drift classified as either male, female or juvenile (duckling)

Correlations between time, tidal height and bird counts

Kruskal-Wallis tests were performed on the data collected in the main survey. These tests resulted in no correlations between tidal height, time of day and gulls/ Great Blue Heron/ Common Merganser.

Analysis of the one day observations was performed by tide and time. The one day observations did result in a significant positive linear correlation (0.94, $p=0.014$) between Common Mergansers and tidal height. There was a negative correlation (-0.566, $p=0.320$) between Great Blue Heron counts and tidal height as well as between gulls (-0.738, $p=0.155$) and tidal height.

Scat Collection

The majority of scat samples were collected from the Cowichan River estuary. Two samples from Great Blue Heron were collected, 35 samples from Common Merganser, 10 samples from gulls sp., 1 sample from a Double-crested Cormorant.

Table 3: Scat collection from birds in the Cowichan River and Cowichan Bay estuary

Date	Species	Location	# collected
18 May 2014	COME	North arm Cowichan River estuary	2
18 May 2014	GBHE	North arm Cowichan River estuary	1
22 May 2014	DCCO	On top of piling	1
22 May 2014	COME	North side of causeway	18
26 May 2014	UNGU	Sarah's cove	10
26 May 2014	GBHE	South side of causeway	1
26 May 2014	COME	South side of causeway	4
30 May 2014	COME	South arm Cowichan River estuary	1
17 June 2014	COME	South side of causeway	6
12 June 2014	COME	Upper Cowichan River	2
16 June 2014	COME	Upper Cowichan River	2
Total collected			**48**

DISCUSSION

Despite the short time span of this survey a high species diversity was recorded in the Cowichan Bay estuary. In addition, we were able to observe the seasonal succession of species. For example, the American Wigeon is reported by local birders to be present throughout the winter, we were able to capture the departure of the American Wigeon and the arrival of the Common Merganser within the time frame of this study. Additionally, It is possible with the data collected to look at the breakdown between males, females and ducklings in the Cowichan River. Males and females were both present in the river until the end of May, at which time the males disappear entirely. Shortly after, the females are seen with ducklings. In the Maritimes it has been documented that broods are raised upstream in rivers containing Atlantic salmon and trout then move to the estuary to feed (White, 1936, 1937, 1957; Anderson, 1985; Anderson et al, 1985). The same progression was observed in the Cowichan Bay estuary. This is not new information and has been documented in other areas. These examples remind us of the ever changing avifauna in the wild and the need to understand what brings them to that particular area at that time.

Potential Predators

The potential impacts of bird predators on juvenile salmon populations is well documented (Mace, 1983; Wood, 1987a; Feltham, 1995; Krohn and Blackwell, 1986; Kennedy and Greer, 1988). We found very few species of piscivorous birds in Cowichan River and Cowichan Bay estuary. Common Merganser, gulls (sp.) and Great Blue Heron were those species present in highest abundance. Other piscivorous species including as the Double-crested Cormorant, Belted Kingfisher, Bald Eagle and Osprey were present in such low abundances that their potential

predation on outmigrating salmon smolt is considered negligible for the observation period of this study.

Common Merganser

For the Common Merganser two conditions have been identified as being required for successful rearing: being near a stream with adequate food supply, and the water being clear enough for food to be caught (White, 1957). Birds are not found on turbid rivers and streams during nesting time but can be found there at other times of the year (White, 1957). This phenomenon has also been observed in the Cowichan River where areas which were traditionally "hot spots" for Common Merganser are no longer and, coincidentally, the water has changed from clear to turbid (J. Saysell, personal communication). We know from our observations that Common Merganser are present in Cowichan River and Cowichan Bay estuary when salmon smolt are outmigrating, however, we do not have evidence that they are or are not consuming salmon. Common Merganser are however, known predators of juvenile salmon (Wood and Hand, 1985; White, 1937; Anderson, 1985; Anderson et al, 1985; Wood, 1985a,b; Wood, 1987 a,b).

In New Brunswick, Anderson (1985) reported that 73% of the diet of merganser was salmon. Erring on the conservative side, Anderson (1985) estimated the Common Merganser consumed on average 14 fish per day in the Restigouche River system with 10 fish being salmon parr. Although they are also opportunistic fish eaters Wood and Hand (1985) found that coho smolt were eaten more frequently than coho fry when they were stocked together in enclosures on Rosewall Creek, BC. Wood and Hand (1985) also found that feeding rates were dependent on density of prey, amount of cover and previous exposure of prey to mergansers. Wood and Hand (1985) also went so far as to state that if Common Mergansers were feeding exclusively on juvenile salmonids (which we do not know that they are in the Cowichan system) they will find adequate food resources during releases of hatchery-reared fish when densities are often increased by two or three orders of magnitude.

Common Merganser have been reported to consume daily, more than one third their body weight in fish (White, 1937). Other reports vary from between one third and one half their body weight per day (Sayler and Lagler, 1940). In general, Common Merganser will feed on any size fish but prefer the largest fish they can possibly swallow (White, 1957; Anderson, 1985). For example, 2-3 day old ducklings feed mainly on insects and some fish up to 2 inches in length (White, 1957). A tame male merganser held in captivity at the Biological Station in St. Andrews had a consumption rate of between 6.25 ounces and 24.25 ounces, an average of 15.8 ounces, 38.5 % of its weight. On one day alone, between 9 am and 5 pm it consumed 59% of its weight in herring and pollock (White, 1957). Daily consumption rate of ducklings was found to be 30.1% (White, 1957).

Our observations this year have provided preliminary information regarding the abundance and distribution of this species during the time of hatchery Chinook salmon outmigration. Through conversations with J. Saysell, we know that in the winter Common Merganser have also been observed feeding on salmon eggs in the Cowichan River. We know from the literature that Common Merganser are salmon predators. We also know that they predate upon many other species of fish. We do not know if Common Merganser are feeding exclusively on any particular

fish species within the context of this study. The data collected to date do not allow for the calculation of salmon mortality due to Common Merganser predation in the Cowichan River or Cowichan Bay estuary.

Gulls

Gulls are another potential salmon smolt and or parr predator in Cowichan Bay estuary. Studies on the Columbia River with various species of gulls (Glaucous-winged Gull hybirds, California Gulls and Ring-Billed Gulls) have shown that proximity of nesting areas to the estuary play a significant role in the proportion of diet attributed to smolt or parr. They found that predation on juvenile salmon in the lower Columbia River was more prevalent in the estuary than further upstream near the nesting colony. Their results also suggested that by encouraging gulls to nest nearer the estuary rather than upstream would reduce the amount of predation on salmon by increasing the marine foraging opportunities (Collis et al., 2002). Gulls have been found to be the most prevalent predator on juvenile salmonids in the Columbia River basin (Jones et al., 1996; Ruggerone, 1986; Thompson and Tabor, 1981) with the estuary supporting three large breeding colonies of Glaucous-winged/Western gull hybrids (A. Clark, USFWS, personal communication In Roby and Craig, 1997). Predation on juvenile salmonids in the Columbia River basin is considered highly significant. The impact of gull predation in the Cowichan River and Cowichan Bay estuary should be further studied.

Great Blue Heron

There are two sub-species of Great Blue Heron found in BC. An inland continental subspecies (*Ardea herodias herodias)* and the coastal subspecies (*A. herodias fannini*) called the Pacific Great Blue Heron. The Pacific Great Blue Heron has been listed as a Species of Special Concern by COSEWIC since 1997. It is also listed under the Province of BC's Blue List. The Strait of Georgia population is estimated at 1833 nests and the entire Canadian population is estimated at between 4,000-5,000 adults (COSEWIC, 2008). The Gulf Islands and Vancouver Island populations together contribute approximately 500 pairs (Chatwin et al., 2009).

A Great Blue Heron colony is present in the town of Cowichan Bay, in 2007, this colony had 93 active nests and was the largest and most successful colony on Vancouver Island (Chatwin et al., 2009). In April, 2008, the heronry moved to the gully below Wessex Road in Cowichan Bay, where it is today. In 2008 there were 45 active nests (Chatwin et al., 2009). The number of active nests in 2012 was 65 in 2013 was 73 and in 2014 was estimated at more than 82 (T. Tripp, Madrone Environmental, personal communication). Because of active construction immediately adjacent to the heronry, Madrone Environmental monitored the area in 2014. Of the 51 nests observed active in 2014, the average number of chicks per nest was 2.7, a total of 140 chicks were observed (T. Tripp, Madrone Environmental, personal communication). Because of the terrain, not all of the active nests could be observed at all times, based on those which could be observed it is estimated that 221 chicks were produced in 2014 (T. Tripp, Madrone Environmental, personal communication). Not all of these chicks survived however, sources of mortality include: falling from nests and predation by American Bald Eagle, Barred Owl and raccoon.

It has been reported that when the tide is low in Cowichan Bay, the herons are able to feed near the rookery and make frequent trips; as opposed to when the tide is higher and they fly over to the Cowichan Bay estuary to feed and make fewer trips back to the rookery (J. Morgen, Madrone Environmental, personal communication). Kelshall and Simpson (1979) found that the most important species of fish to Great Blue Heron hunting in tidal mud flats in the lower mainland area of BC were, in order of importance, threespine stickleback (*Gasterosteus aculeatus*), saddleback gunnel (*Aphodichthys flavidus*) and 4 other blennies, staghorn sculpin (*Leptocottus armatus*) and other sculpin species. Birds were also observed to feed on salmon species but they were not the main prey. Other species such as flounders, sea perches and gobies were also consumed by Great Blue Heron (Kelshall and Simpson, 1979). Most importantly, the study shows the change in diet was reflected in the percent composition of species captured during beach seines. In other words, the diet of Great Blue Heron in mud flat tidal areas was dependent on species present, they were not necessarily selectively foraging.

In Summary

In 2014 there were two releases of hatchery Chinook salmon into the Cowichan River. The first release of 107.5K fish was on the 23rd of April at Road Pool in Lake Cowichan, the second release of 120K fish was on May 15th approximately 0.5 km below the silver bridge in Duncan (Trans Canada Highway). From our surveys we are able to determine that there were piscivorous birds present in the reach of the Cowichan River above Skutz Falls as well as in Cowichan Bay estuary at these times and shortly after. We do not have evidence that they were preying on salmon however, we only have evidence that potential predators were present. Scat samples were collected from Common Merganser, gulls and two Great Blue Heron which are available for DNA analysis to determine if they were consuming salmon.

Distribution

Total and average species counts varied significantly between observation locations. This is not surprising as the observation areas are composed of different habitats and are of varying sizes. For example, the Tower Nature Centre area contains very little mud flat habitat at low tide, as compared to the Tower Farm location. It was evident that the best locations to observe Common Merganser and Great Blue Heron are in the KGL, Causeway and Tower Farm areas. The Tower Nature Centre was a very good location to observe gulls. Because there is an application put forward to breach the causeway to allow water to flow from the north side of the causeway to the south side, it is expected that there will be changes in the distribution of birds with changes in freshwater and saltwater flows in the immediate estuary area. This makes it all the more important to understand the ecology of the estuary including the fish, bird and small mammal habitat in the immediate area.

Although only one full day of bird observations is available, in the areas observed, the number of Common Mergansers was positively correlated with tidal height. This preliminary information does suggest that if future studies were looking to enumerate Common Mergansers in Cowichan Bay estuary, the best time to observe them would be at high tide. The same does not hold true for gulls or Great Blue Heron in this area.

RECOMMENDATIONS

Cowichan Bay Estuary

- *Create an annual profile of species and abundance through twice monthly surveys of three areas: Khenipsen Rd and /or Gore Langton Rd (KGL), Causeway and Tower Farm.*

  Current data are not sufficient to understand the interaction between the bird and fish populations in the estuary. In the long term, it is important to collect these data in order to be able to speak to changes in fish and bird assemblages after the breaching of the causeway.

Cowichan River

- *Create an annual profile of species and abundance through twice monthly surveys of upper, mid and lower reaches of Cowichan River.*

  We know predation occurs by birds on fish populations in the Cowichan River. Current data are not sufficient to determine the intensity or breadth of predation. Anecdotal information tell us that predatory birds are present year round in certain areas of the river. Hatchery and wild salmon management strategies can be informed once we understand where and when predators are present as has been done in other rivers.

Scat

- *Determine methodologies to analyse scat samples from birds for all salmon species.*

  It may be necessary to hold birds in captivity and feed known species of salmon in order to verify the results of DNA analysis of scat.

- *Collect more Great Blue Heron scat for analysis.*
- *Collect scat from Common Merganser throughout the year on the Cowichan River.*

  It is believed that Common Merganser are consuming salmon eggs during the winter while the eggs are incubating in redds. In order to determine the extent of predation, it is necessary to collect scat from predatory birds, and Common Merganser in particular, throughout the year in the river.

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